NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
4080402	January, 1971	10387

A STUDY OF SEAT BELT BUCKLE RELEASE METHODS

by

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U.S. DEPARTMENT OF COMMERCE

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I. INTRODUCTION

The Occupant Restraint Systems Section of the Office of Vehicle Systems Research has obtained a number of seat belt assemblies which represent a cross section of those used in 1969 vehicles sold in this country. This group of assemblies, both foreign and domestic, provides examples of a large variety of buckle release methods.

These samples and others obtained over the past few years have been evaluated and analyzed for the purpose of determining whether or not there should be a single standardized method of buckle release prescribed in the Federal Seat Belt Standard and, if so, what that release method should be.

II. BACKGROUND

The present requirements of Motor Vehicle Safety Standard No. 209 do not specify the use of any particular type of device to secure a person in a seat belt assembly. The general requirements section of the Standard specify that there shall be no burrs or sharp edges which can contact a person, clothing, or webbing, and that buckles be readily accessible to the occupant for his easy and rapid release. The Standard further specifies that all buckle release mechanisms shall be designed to minimize the possibility of accidental release. The accidental release requirement was of primary importance in the evaluation of existing designs.

Personnel of the Occupant Restraint Systems Section have been, and are now, taking an active part in several Society of Automotive Engineers Committees which are concerned with seat belts. The question of standardization of a single release method has been discussed by these committees for several years and, basically, two positions have been presented. The first position, supported by the Occupant Restraint Systems Section personnel and others in the past, was that a single method of operation of a release system should not be prescribed in a standard. The adoption of such a requirement would have had the tendency to stagnate a relatively new area of engineering design and discourage innovation which could produce a more effective system.

The second position, presented from a user's standpoint, was that a single release system should be specified in a standard. The main reasons for this approach was that users would always be faced with the same type of release operation in an emergency, and seat belt usage would be greater if the public were not confused with a variety of devices. It was also recognized that a large percentage of the public is not mechanically oriented and certainly some existing systems appeared complicated.

III. DESIGN REVIEW

A design review of a cross section of seat belt assemblies, representative of those sold in this country, was conducted to determine what existing features of release devices which were detrimental to or beneficial in improving their safety and gain greater public acceptance.

All of the samples reviewed presented a means of quick release and in many cases, some offered small advantages over others.

The widely used lever or lift cover buckle presents several disadvantages in normal usage. The action required to effect a release (see Fig. 1 and 2) varies from either a push or pull, depending on which hand is used and in both cases the direction of the action required tends to keep the tongue and buckle engaged. When the lever or lift cover pivot is located so that the release action tends to separate the mating parts, the fingers or fingernails are then exposed to possible damage as the assembly separates (Fig. 3). Some models of a lever type buckle require an excessive amount of lever travel in order to effect a release and this may be difficult to accomplish in an emergency, especially if there are any restrictions on body movement as a result of a collision. The position of the lever shown in Fig. 4 (almost 90°) is the minimum distance that the lever must travel in order to effect a release.

A serious disadvantage in panic release of a lever type is incurred when changing positions from one side of the vehicle to the other, say, from passenger to driver. The releasing action for the same hand is reversed from a pull to a push or vice-versa, or the buckle must be released with the opposite hand to maintain the same action.

Some of the more unique systems reviewed, not common in this country, presented a variety of release techniques which contain several disadvantages. The first and most important of these is that the release lever is extremely vunerable to accidental release through

inadvertent contact with the occupant's hands, arms, or clothing (see Fig. 5). The lever of this buckle is also openly exposed to damage by a closing door or folding seat which may cause it to be inoperable or unsafe. This buckle assembly, including the tongue, is over six inches in length and presents the user with a large metallic object which must come in contact with his body. Such a buckle is uncomfortable to a user and would increase the possibility of injury to the abdomen or skeleton in a collision.

Another unique system designed to be mounted rigidly between two bucket seats (see Fig. 6) is susceptible to accidental release by contact with an occupant's extremities. This particular model, with the sharp release levers protruding, also exposes an occupant to possible injury from the hardware during collision. An advantage of this type of system is that the assembly is mounted in a fixed position which makes one hand operation extremely easy and keeps all the hardware off the body.

Several systems reviewed present a user with either no obvious operation point or a misleading operating point. Although the two systems shown in Figs. 7 and 8 operate well, there is no indication, through design or labeling, to direct a person where or how to effect a release. In Fig. 7 the release mechanism is operated by applying a force on the knob in the direction indicated by the arrows and the assembly shown in Fig. 8 is also released when a force is applied on the bar in the direction indicated by an arrow. The buckle in Fig. 9 is actually a lever release (liftcover) type but through ornamentation and cover design this buckle could easily appear to the user to be a

pushbutton type.

IV. DESIGN CRITERION

In an effort to determine whether a single type of release method should be specified by a federal standard, a study and evaluation of the various seat belt release systems was conducted. This study was directed towards a determination of what advantages and disadvantages were offered by the existing systems of vehicles sold in this country. The study indicated that any single type of release mechanism adopted should include as many of the following desirable features as possible.

(a) Any release device must meet the present applicable requirements of MVSS 209.

(b) The operation should be easily and quickly accomplished with either hand by the same relative motion. (See Figs. 10 and 11).

(c) The direction of the force required to effect a release should not tend to keep the assembly together when the latching mechanism is opened. (See Fig. 1).

(d) The area of the release mechanism where the release effort is to be applied should have sufficient protection to prevent accidental operation of the device by the arms, hands, and clothing. (See Figs. 5 and 6).

(e) The direction of the forces on the release mechanism, due to the vehicle frontal impacts (deceleration) should tend to keep the latching device closed.

(f) The operation of the release mechanism shall require one

and only one continuous motion.

(g) The release device shall be protected so as to minimize the possibility of objects, such as buttons and cuff-links, getting into the mechanism.

(h) In normal usage a person's body or clothing should not interfere with the operation required to release the assembly.

(i) The operation of a release mechanism should be accomplished without the fingers or fingernails being exposed to damage when the assembly separates. (See Fig. 3).

(j) The design of any release device should obviously direct a user to the operating area and the cover of any device should not have any design or emblem which falsely implies an operation point. (See Figs. 7, 8, 10 and 11).

(k) There shall be no projections of levers or handles which could cause a serious injury to a belted or unbelted vehicle occupant. (See Fig. 6).

V. RECOMMENDATIONS

Seat belt assemblies have been required as standard equipment in all passenger vehicles sold in this country for several years. The seat belt industry has now had sufficient time, with no restrictions on release mechanism design, to develop a great number of systems. Since no radically new designs have appeared for several years, the Occupant Restraint Systems Section recommends that a single type of release for all seat belt assemblies should be specified in a Federal

Standard.

As far as the public is concerned, the adoption of a single type of release would benefit all, particularly those who are not mechanically oriented, by exposing them to one and only one simple type of release action.

After the examination and evaluation of the different existing systems that have been and are now being used, the pushbutton type of release appears to be the logical type to specify.

The reasons which led to selecting the pushbutton type operation over other types are presented in three following categories.

(a) Service and reliability

The pushbutton buckle has been in use in this country since late 1964. This period of time represents a significant test period for such a system and the results have been very satisfactory. In some isolated instances, problems have arisen and the manufacturers have made slight design modifications to eliminate these problems. The system, as we know it today, has a very high level of reliability and meets all of the existing Federal specifications concerning release mechanisms.

(b) Desirable features

The pushbutton release presents the user with one single operation which may be accomplished easily and quickly in the same manner with either hand and thus allows the device to be used on the inboard end of belts for either side. This is in contrast to the single ended lever type

which requires release with the opposite hand when the buckle is placed inboard on the opposite side of the vehicle.

This type of system also complies with those design criteria set forth in Section III as desirable. Several other types of release devices qualify partially with the above statements but none to the extent of the pushbutton type. Any release device which is selected to be specified certainly should have a period of exposure to general usage and not introduce some unique operational action.

(c) Usage and acceptance

Seat belts have been installed by the automobile manufacturer as standard equipment in outboard front seats since 1964 and in all seated positions since 1968. According to vehicle population figures, approximately 70 percent of all passenger vehicles on the road today have seat belts in the outboard front seats and 35 percent have seat belts in all seated positions. The pushbutton system was first introduced in 1964 and the use of this type of system has greatly increased each year to the extent that in 1970 approximately 85 percent of all original equipment seat belts used are pushbutton. The predicted figures for 1971 model vehicles show that 97 percent of all seat belt assemblies installed as original equipment will have a pushbutton type release. The increase in acceptance of the pushbutton, both by the automotive industry and the using public, presents a strong indication that if all seat belt

assemblies were equipped with this same type of convenient release device, the percentage of people who would wear them would also increase.

VI. ADDITIONAL REQUIREMENTS

In addition to a requirement that only a pushbutton type release system be acceptable, the following items should be considered for inclusion in a Federal Standard which should improve the operation, reliability and encourage more usage.

(a) Enclosure #1. The National Bureau of Standards Proposed Revisions to Motor Vehicle Safety Standard 209 should be adopted.

(b) The area in which the release force is to be applied should be labeled "push". The color of the area should also be in contrast with the cover and no insignia or other design which could be confused with the pushbutton should be allowed. (See Fig. 12).

VII. CONCLUSIONS

The pushbutton type release system employed in a large majority of vehicles, both foreign and domestic, sold in this country should be specified in a Federal Standard as the only acceptable means of releasing a seat belt assembly. The adoption of this and the preceding recommendations would increase the usage of seat belts by the public and add to the safety value provided by them.

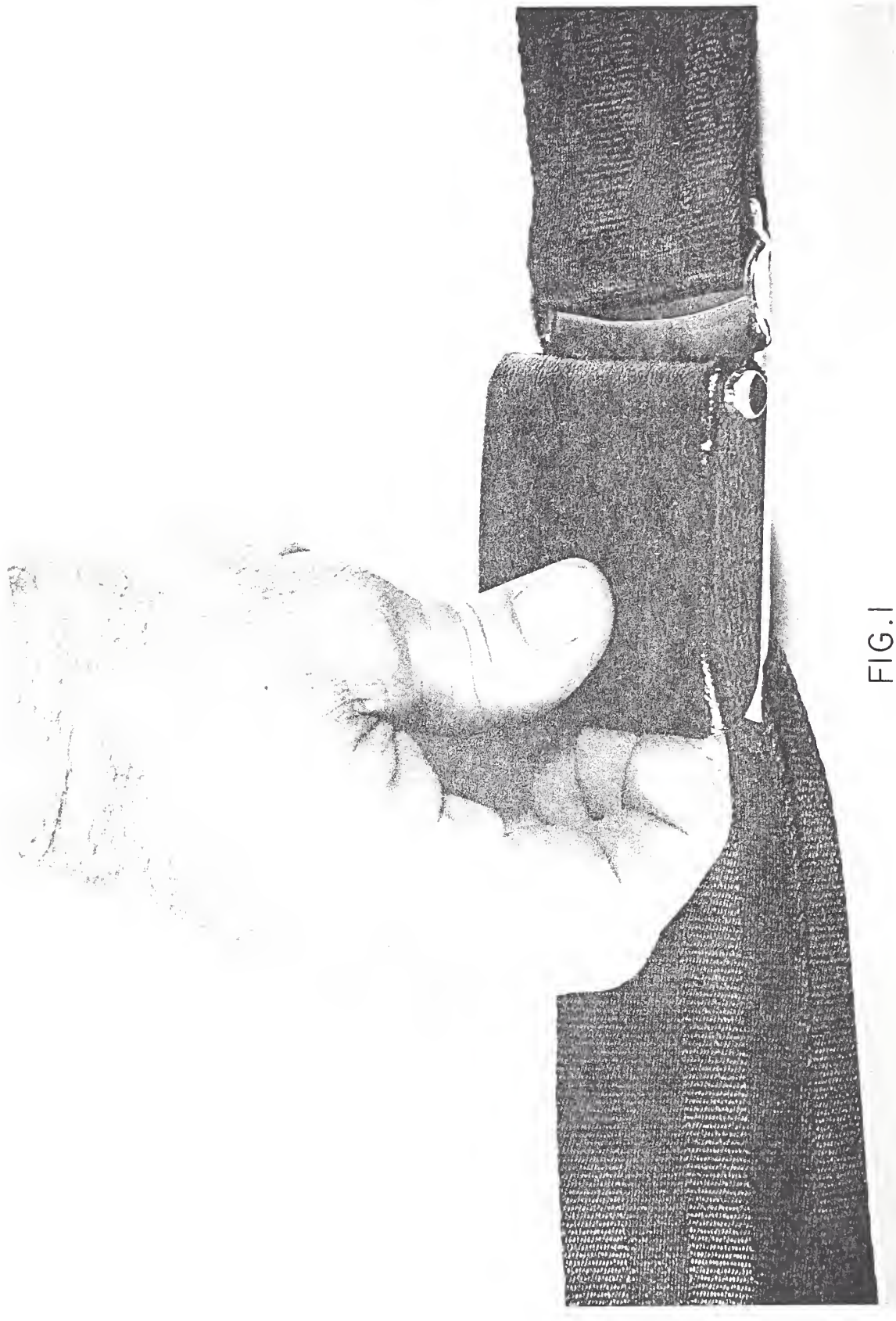


FIG. 1

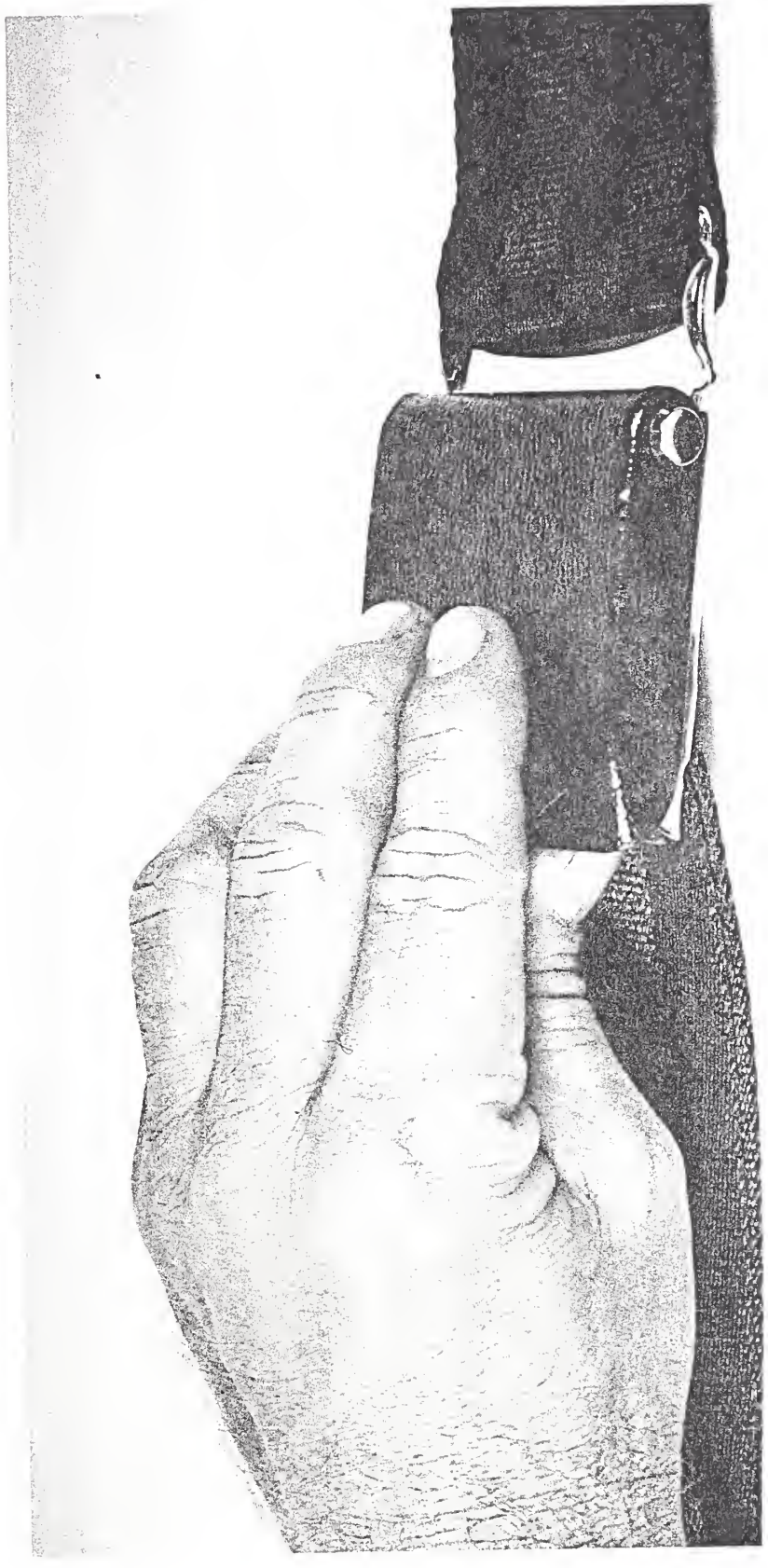


FIG. 2

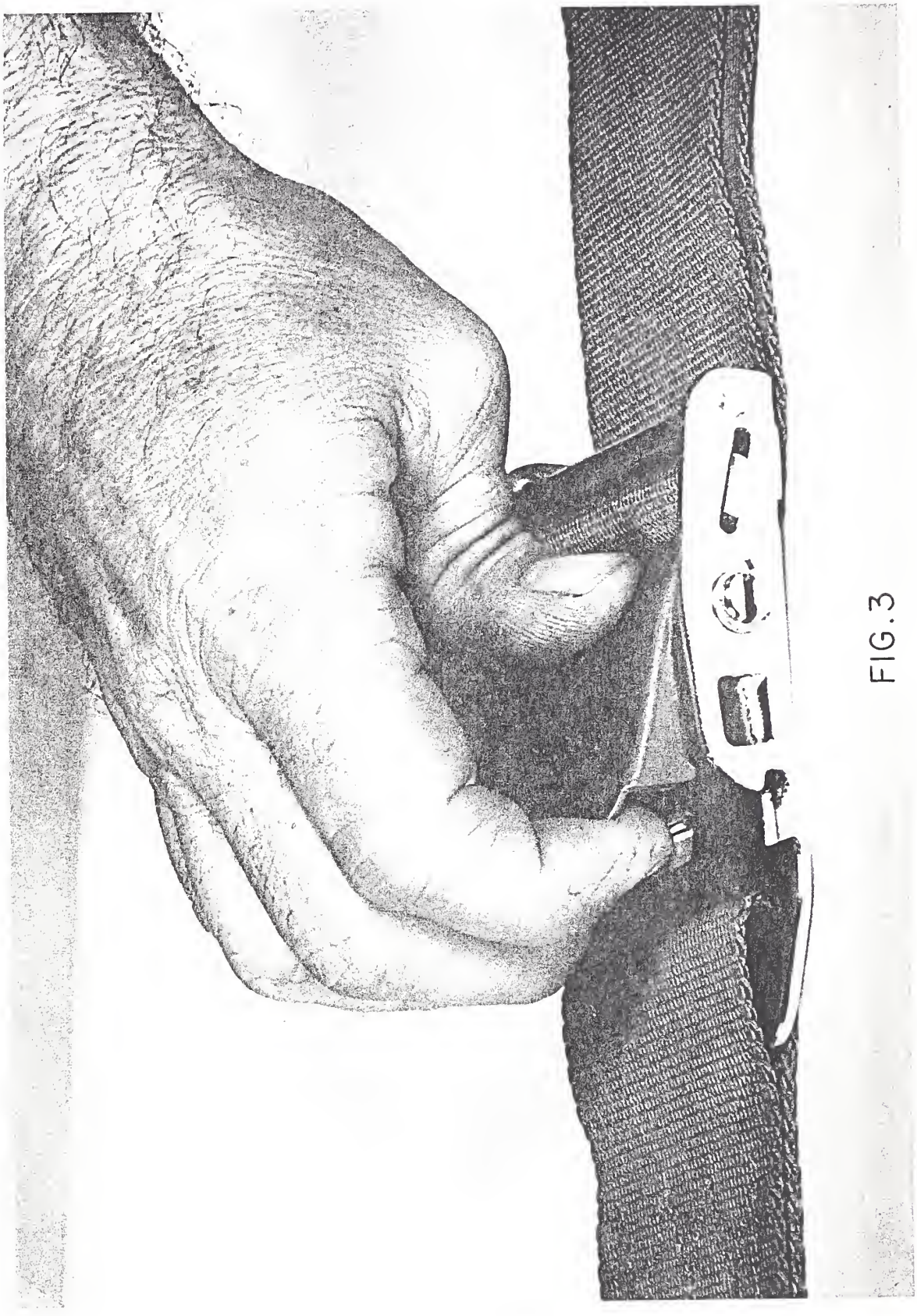


FIG.3

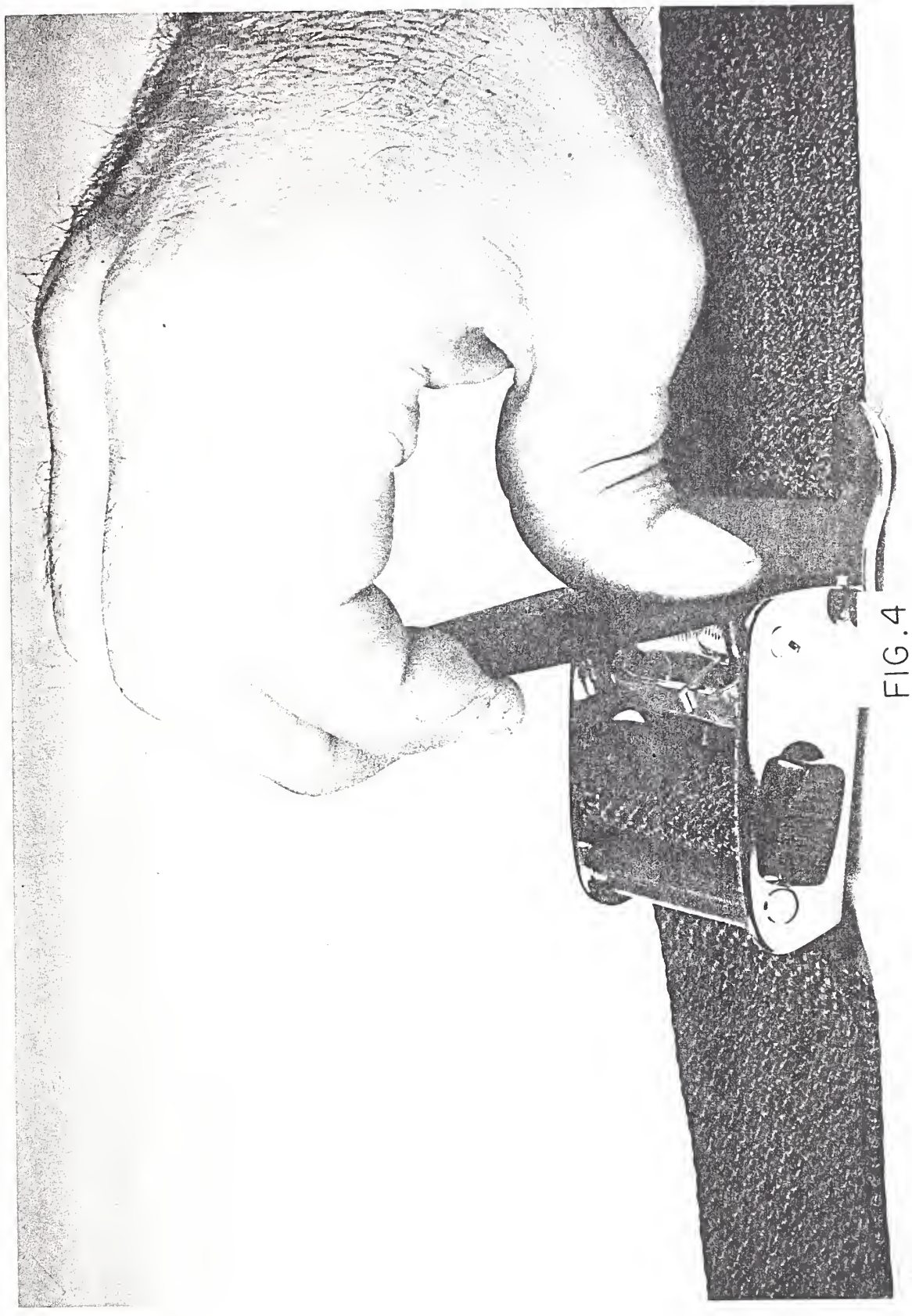


FIG. 4

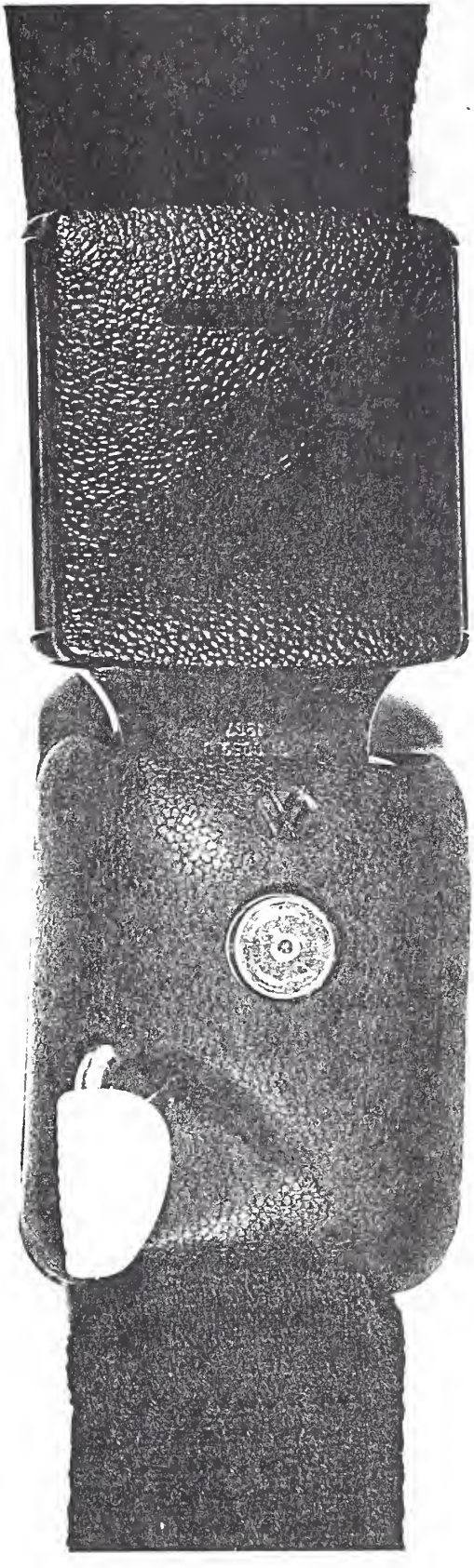


FIG.5

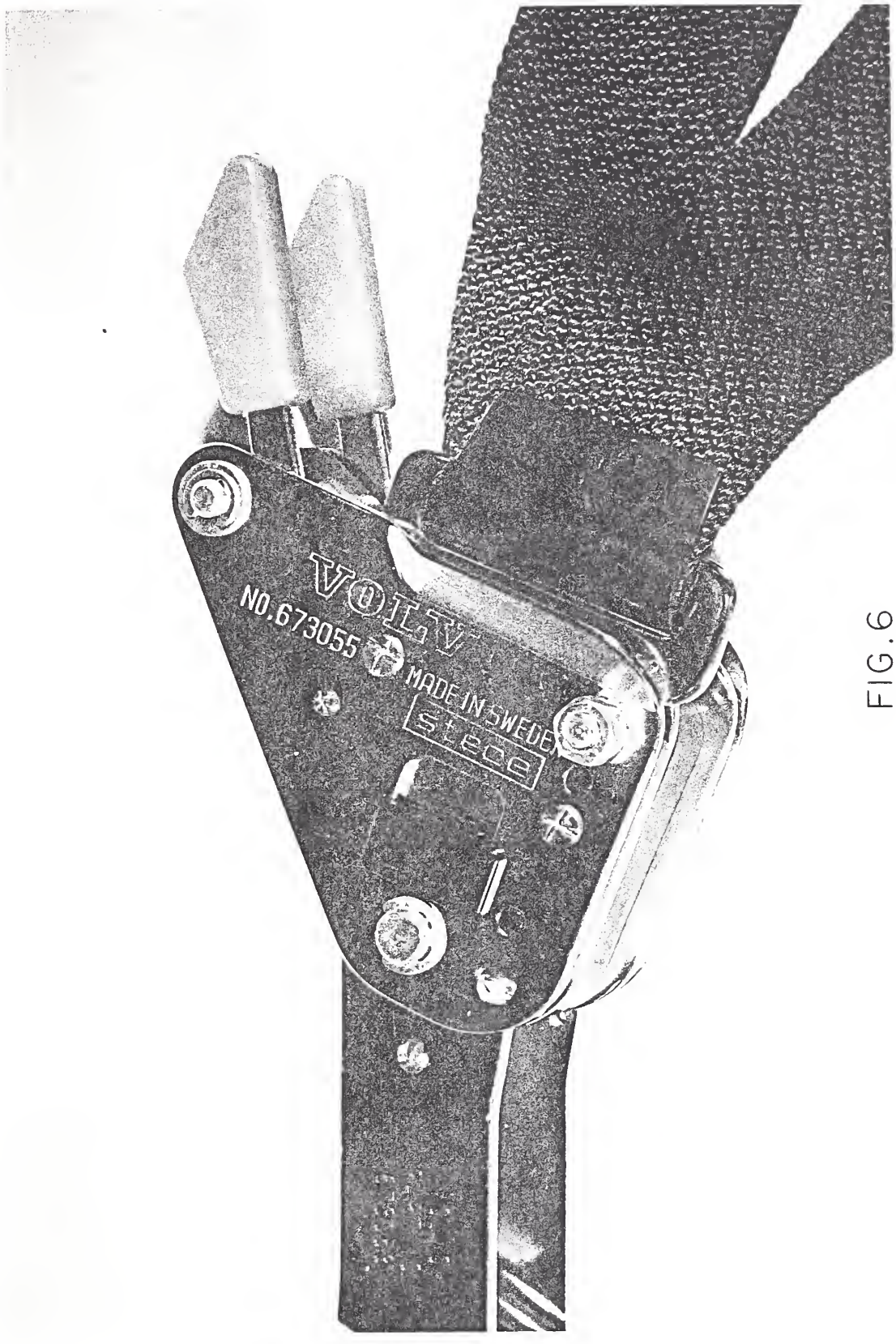


FIG.6

FIG. 7

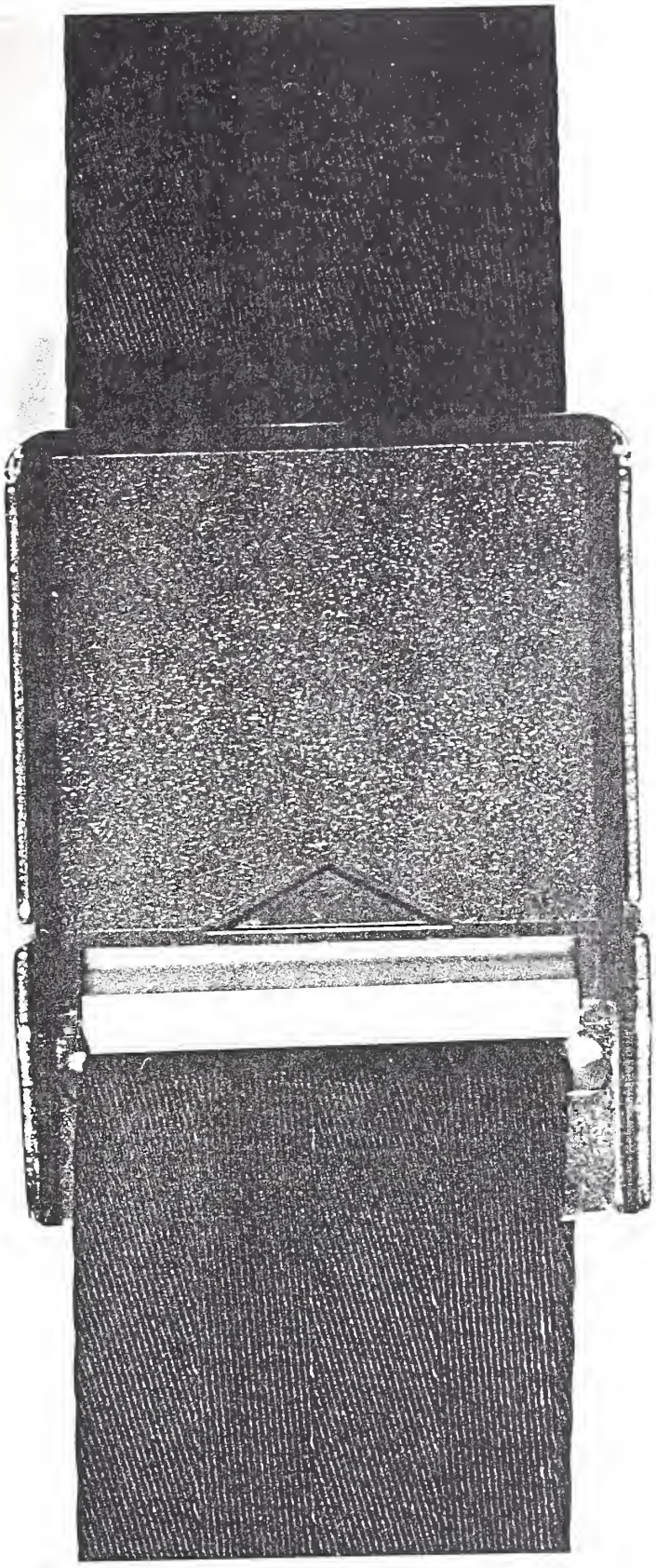


FIG.8

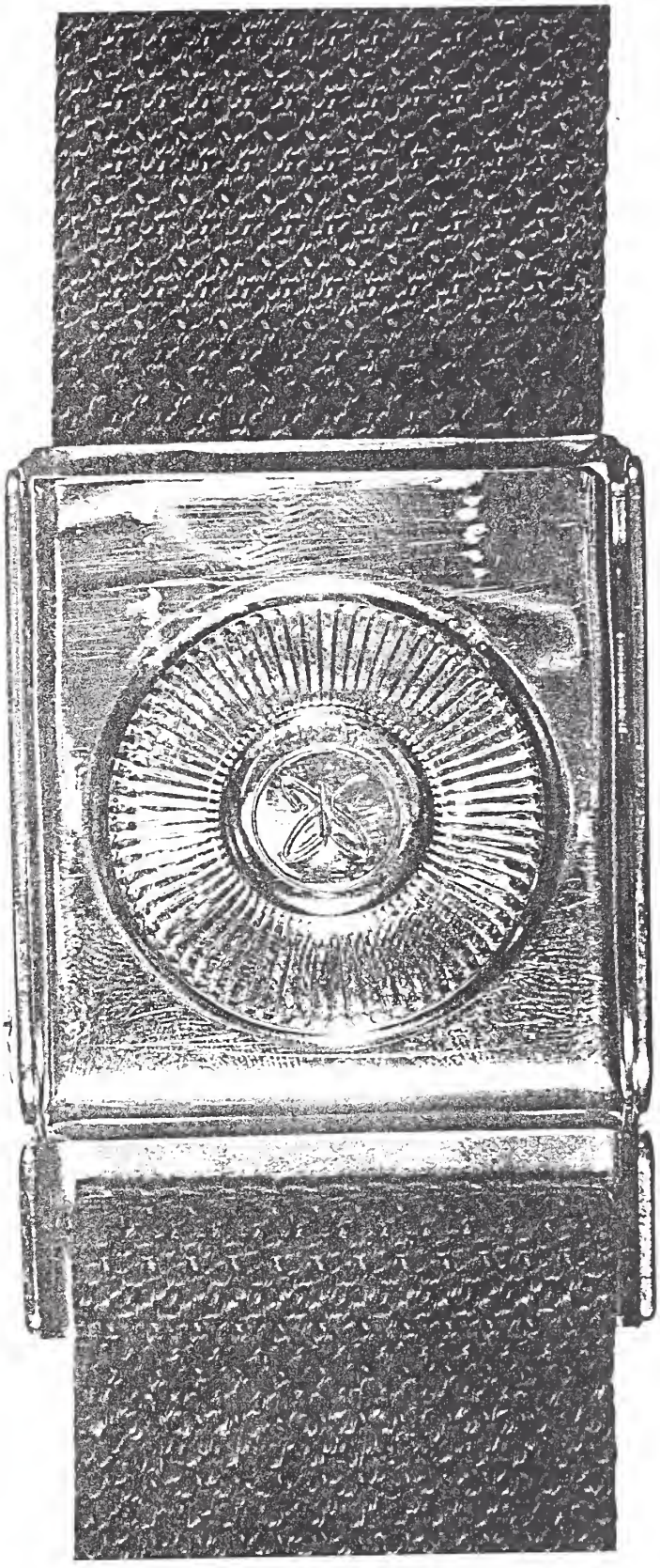


FIG.9

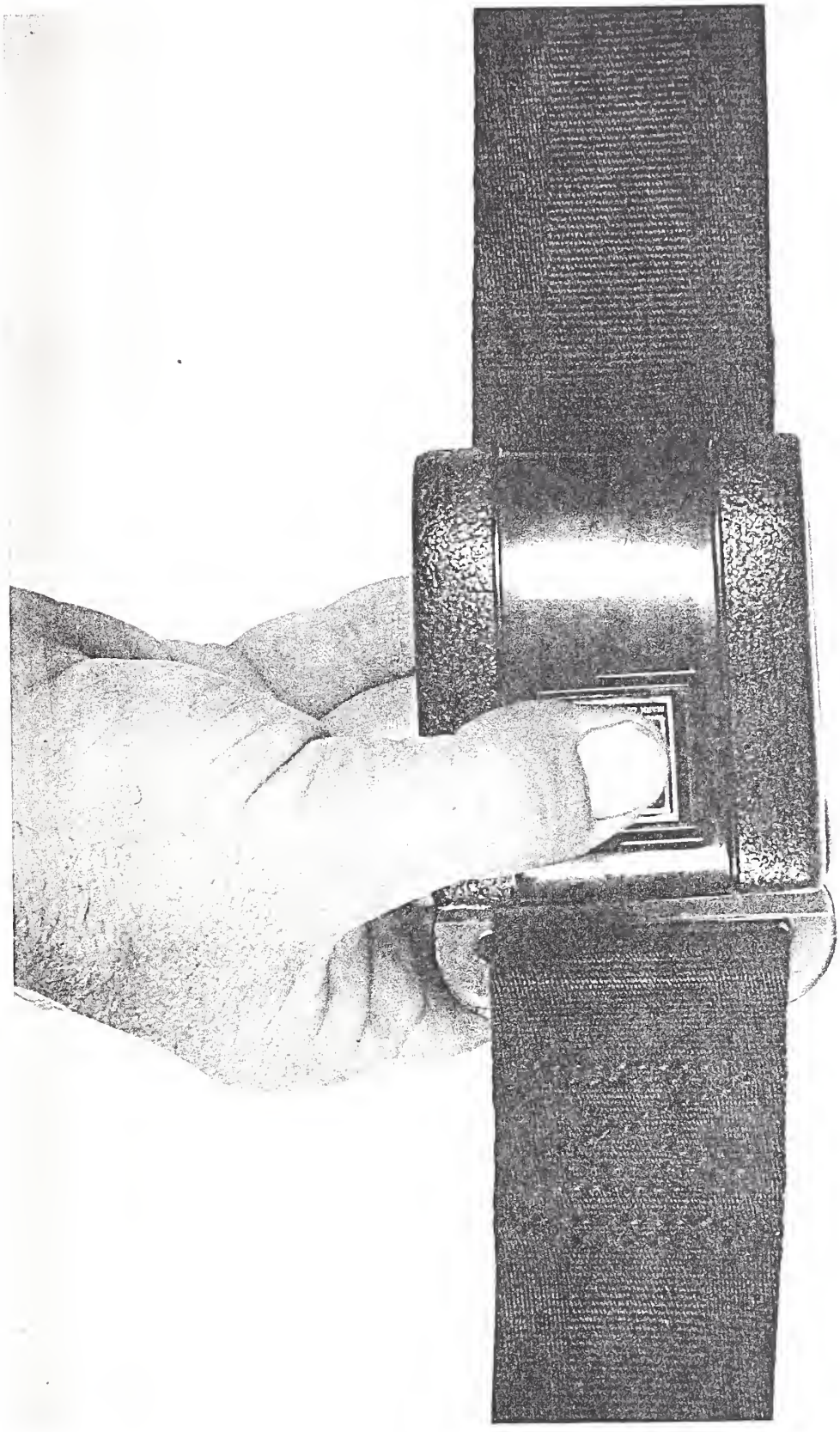


FIG. 10

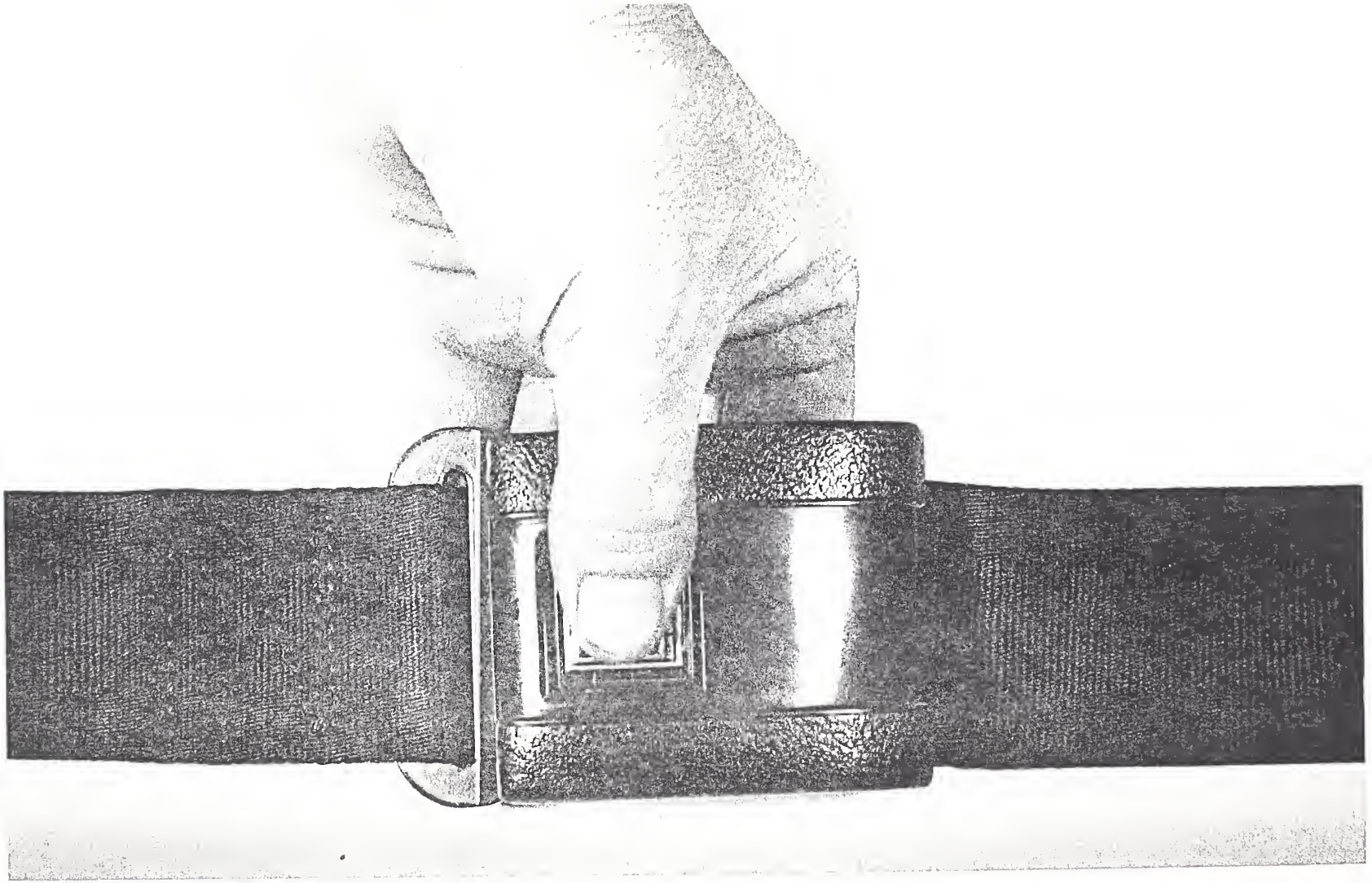


FIG.11

FIG.12

NBS PROPOSED REVISIONS TO MOTOR
VEHICLE SAFETY STANDARD NO. 209;
SEAT BELT ASSEMBLIES

Motor Vehicle Safety Standard No. 209 (32 FR 2415) incorporated by reference the requirements of the Department of Commerce, National Bureau of Standards, Standards for Seat Belts for Use in Motor Vehicles (15 CFR Part 9; 31 FR 11528). The following revisions to this Standard are recommended:

I. BUCKLE RELEASE

Discussion:

In tests conducted at NBS, buckle release or malfunction occurred with a compressive force of as little as 275 pounds when the force was applied in surface areas other than the area directly over the pushbutton. It is recommended that a new test procedure be required that would apply the present force of 400 pounds in all areas of the surface of the buckle. It is also recommended that this requirement be extended to all types of buckles, including lever, squeeze, etc. This new test will tend to eliminate buckle designs that are prone to accidental damage which would reduce their load carrying effectiveness. It also reduces the probability of buckle release during the initial phases of an accident. The Society of Automotive Engineers is planning to adopt an identical requirement in the next revision of the SAE J4C Seat Belt Standard.

Revisions to Standard:

1. Rewrite paragraph 9.5 (d)(3) as follows: "A buckle of a Type 1 or a Type 2 seat belt assembly shall not release under a compressive force of 400 pounds or 180 kilograms applied as prescribed in paragraph 9.8 (d)(1) and shall be operable and meet the applicable requirements of paragraph 9.6 upon removal of the compressive force".

2. Paragraph 9.8 (d)(3). Delete the entire paragraph and substitute the following: "The buckle of a Type 1 or Type 2 seat belt assembly shall be subjected to a compressive force of 400 pounds or 180 kilograms applied anywhere on the center line and along lines at approximately 60 degrees to the center line, with the point of intersection of these lines centered over the release mechanism, through a cylindrical bar 0.75 inch or 2 centimeters in diameter and curved to a radius of 6 inches or 15 centimeters. The bar shall be placed with the center line of the bar directly above the lines through the center line of the buckle and at approximately 60 degrees to it. The buckle shall be engaged and a tensile force of 75 pounds or 34 kilograms shall be applied to the connected webbing during the application of the compressive force. Buckles from three seat belt assemblies will be tested to determine compliance with paragraph 9.5 (d).

II. BUCKLE LATCH

Discussion:

During NBS dynamic tests conducted at Holloman Air Force Base,

using anthropometric dummies (Alderson Model F-50), two buckle latch failures occurred. Static laboratory tests of buckle latches were set up at the National Bureau of Standards, in which the tensile force was applied at 30 degrees to the transverse belt direction. These tests indicated that the strength of certain buckle latch arrangements were reduced by as much as 50 percent to a figure of 1500 pounds total tensile strength. This failure is attributable to the rounding of the tongue of these designs which is used to improve the ease of tongue insertion into the buckle. Minor changes of the tongue and/or latch construction would eliminate this potential weakness.

Revisions to Standard:

1. Paragraph 9.5(g). Add the arabic numeral 1 in parenthesis following the paragraph designation as "Paragraph 9.5(g)(1)".
2. Add a second paragraph to paragraph 9.5(g) as follows: "(2) The buckle of a Type 1 or a Type 2 seat belt assembly when tested by the procedure specified in paragraph 9.8(g)(2) shall not fail and shall be operable and meet the applicable requirements of paragraph 9.5(d)(1). The load applied to the Type 1 and Type 2 seat belt assembly shall be 2,000 pounds or 910 kilograms and 1250 pounds or 570 kilograms, respectively."
3. Add the paragraph symbol "(1)" following the words "Buckle Latch".
4. Paragraph 9.8(g)(2). Add the following test: "The buckles and webbing from three seat belt assemblies shall be tested

in the following manner: The testing machine shall conform to the requirements specified in paragraph 9.7(b). A split drum grip equivalent to that of Figure 1 shall be used in one head of the machine to grip the webbing of the buckle. A gripping device similar to that one in Figure 9 is used to hold the tongue to the other head of the machine so that it is loaded at a 30 degree angle in the transverse plane of the webbing. The rate of grip separation shall be between 2 and 5 inches per minute or 5 and 10 centimeters per minute. The seat belt assembly shall be loaded until the values specified in paragraph 9.5(g)(2) are applied.

5. Add Figure 9 as shown in attached sketch.

III. REDUCTION OF BUCKLE RELEASE FORCE

Discussion:

A reduction of buckle release force is desirable so long as the other security aspects of the seat belt assembly are maintained. It is recommended that the 150 pound loop load for the 30 pounds release force be increased to 200 pounds. This is equivalent to a reduced release load of 22.5 pounds with a loop load of 150 pounds. Only the pushbutton type of design will be affected to any degree by this recommended reduction in release force. Two major manufacturers of seat belt assemblies already have prototypes of buckles which will meet this new requirement.

Revision to Standard:

Paragraph 9.8(d)(1). Change 150 $\pm$ 10 lbs. to 200 $\pm$ 10 lbs. and

change 68 ± 4 kilograms to 91 ± 5 kilograms.

IV. EMERGENCY LOCKING RETRACTORS

Discussion:

The emergency locking retractor accomplishes two objectives:

1. Stowing the webbing when not in use
2. Permitting relatively free motion while wearing the webbing from the retractor.

In the few production models of this device to date, many can and do lock at very low g levels, such as 0.2 gravity, due to manufacturing tolerances. Locking at this very low critical level makes it difficult to don a seat belt assembly and discourages the use of emergency locking retractors (inertia reels). It is recommended that a lower limit of 0.3 gravity be specified for non-locking of the retractor.

A recent development in emergency locking retractors is an arrangement in which the first few feet of webbing extraction does not involve any locking and enhances ease of donning this type of seat belt assembly. It is recommended that a statement be made in the standard which would permit this desirable alternative type of design.

Revisions to Standard:

1. Paragraph 9.5(j). Add in the first sentence after "0.5 gravity or 5 meters per second per second" the following "but shall not lock when exposed to 0.3 gravity or 3 meters per second per second or less, etc." At the end of this paragraph, add the words "These requirements need only apply for

and only one continuous motion.

(g) The release device shall be protected so as to minimize the possibility of objects, such as buttons and cuff-links, getting into the mechanism.

(h) In normal usage a person's body or clothing should not interfere with the operation required to release the assembly.

(i) The operation of a release mechanism should be accomplished without the fingers or fingernails being exposed to damage when the assembly separates. (See Fig. 3).

(j) The design of any release device should obviously direct a user to the operating area and the cover of any device should not have any design or emblem which falsely implies an operation point. (See Figs. 7, 8, 10 and 11).

(k) There shall be no projections of levers or handles which could cause a serious injury to a belted or unbelted vehicle occupant. (See Fig. 6).

V. RECOMMENDATIONS

Seat belt assemblies have been required as standard equipment in all passenger vehicles sold in this country for several years. The seat belt industry has now had sufficient time, with no restrictions on release mechanism design, to develop a great number of systems. Since no radically new designs have appeared for several years, the Occupant Restraint Systems Section recommends that a single type of release for all seat belt assemblies should be specified in a Federal

required, additional anchorages for Type 3 seat belt assemblies should not be necessary. To encourage the use of Type 3 assemblies, it is recommended that the anchorages already required be used for their installation. It is also recommended that retainers for Type 3 seat belts should use the Type 1 and Type 2 seat belt anchorages already specified.

Revisions to Standard:

1. Add to paragraph 9.3(f)(1) the following: "The attachment mechanism of the Type 3 assembly shall be designed to utilize the Type 1 and Type 2 seat belts and anchorages."
2. Paragraph 9.3(h). Seat belt retainer. Add to the end of the paragraph the following sentence: "The retainer shall be designed to utilize the Type 1 and Type 2 seat belts and anchorages."

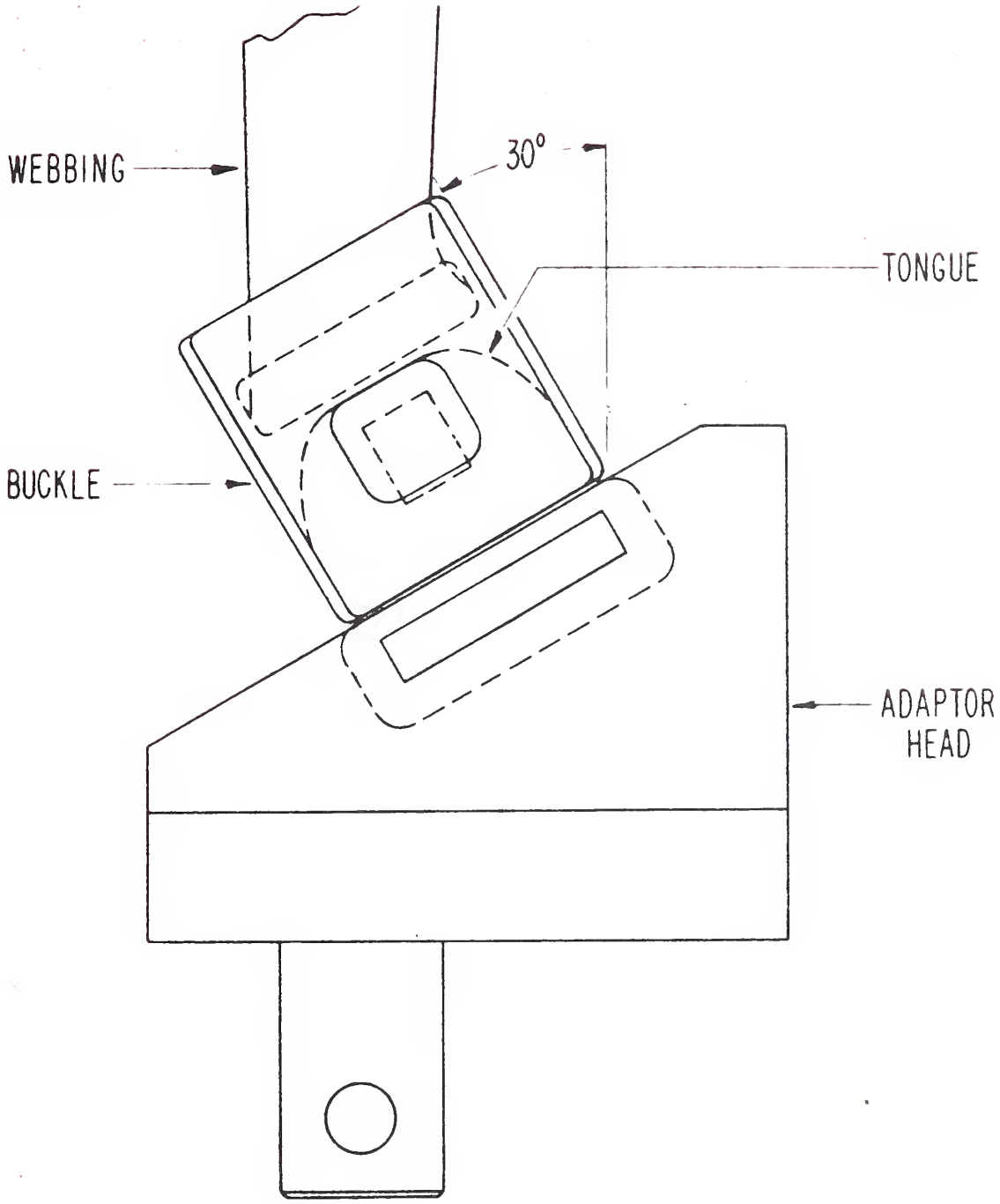
VII. EDITORIAL CHANGES

Discussion:

The Figure 3 label was inadvertently left out. The addition of the word "exposed" in the notation A is recommended so that the words will agree with the text where this figure is referenced.

Revisions to Standard:

1. Label the figure on page 11537 "Figure 3".
2. Change notation A in this figure to read: "A - 2 full threads exposed."



BUCKLE TEST FIXTURE

FIGURE 9

RECOMMENDED ABRASION TEST OF SEAT BELT
ASSEMBLY LENGTH ADJUSTMENT DEVICES

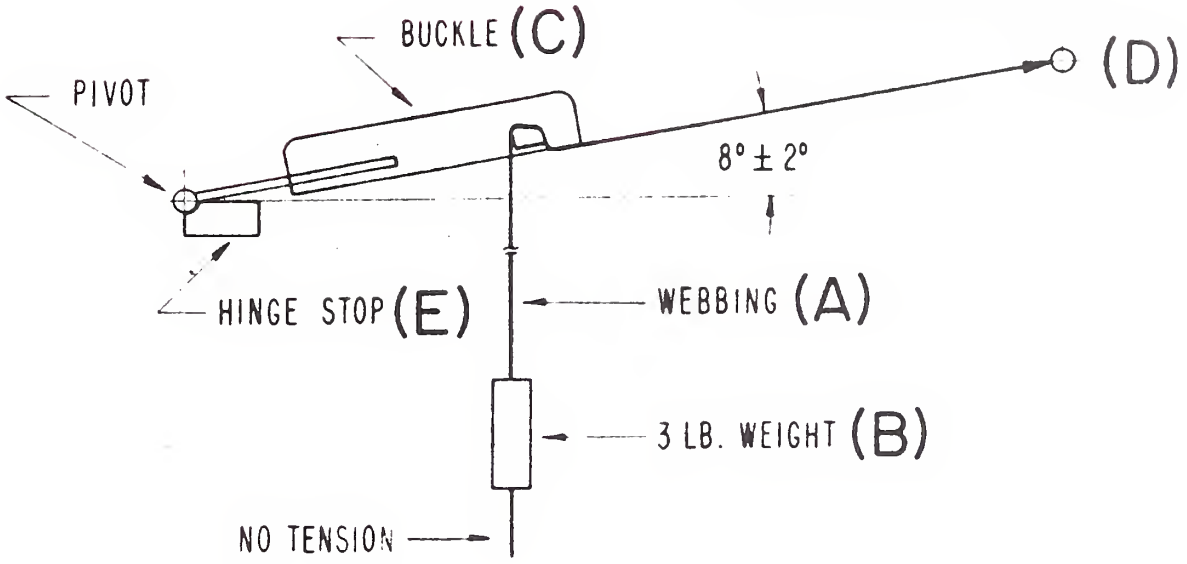
9.6 Requirements for assembly performance

(d) The webbing in a seat belt assembly, after being subjected to abrasion as specified in paragraph 9.9(d) shall have a breaking strength not less than 75 percent of the strength before abrasion when measured by the procedure specified in paragraph 9.7(b). At the completion of the abrasion cycling the assemblies shall meet the requirements set forth in paragraphs 9.5(e) and 9.5(f).

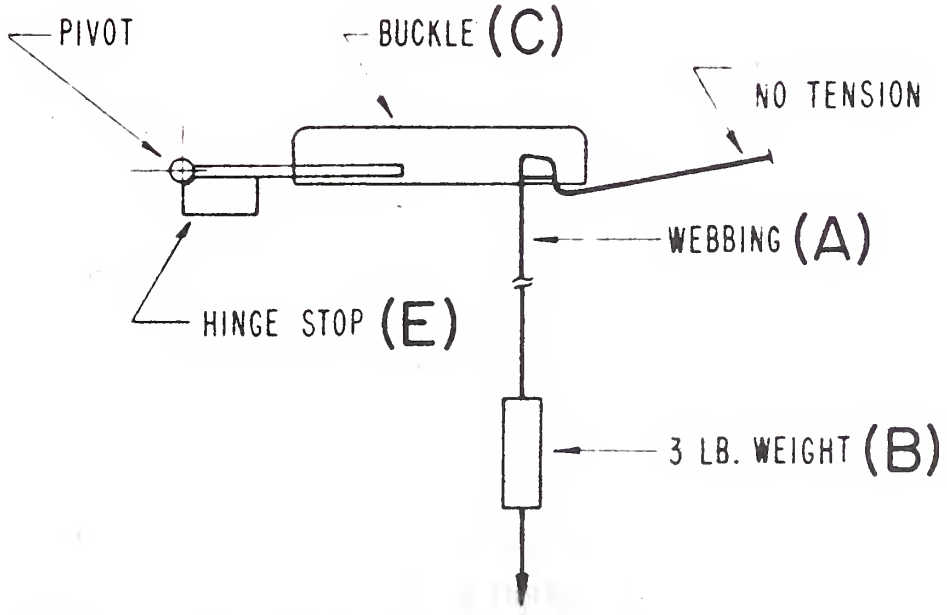
9.9 Test procedure for assembly performance

(d) Resistance to abrasion. Three seat belt assemblies shall be tested for resistance to abrasion at the buckle or any manual adjusting device normally used to adjust the size of the assembly. The webbing of the assembly to be used in this test shall be exposed for at least four hours to an atmosphere having relative humidity of 65 ± 2 percent and a temperature of 21 ± 2 degrees Celsius or 70 ± 3 degrees Fahrenheit. The webbing shall be cycled through the buckle or manual adjusting device as shown schematically in Figure 9. The anchor end of the webbing (A) shall be attached to a weight (B) which has a mass of 3.0 ± 0.1 pounds or 1.4 ± 0.05 kilograms. The webbing shall pass through the buckle (C) and the other end (D) attached to a reciprocating device so as to form an angle of 8 ± 2 degrees with the hinge stop (E). The reciprocating device shall be operated for 2500 cycles at a rate of 18 ± 2 cycles per minute with a stroke length of 6 to 8 inches. The abraded webbing shall be tested for breaking strength by the procedure described in paragraph 9.7 (b) and each valve shall not be less than 4500 pounds but the median values for the breaking strengths determined on abraded and unabraded specimens shall be used to calculate the percentage of breaking strength retained.

SHORTENING STROKE



LENGTHENING STROKE



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